EPIC: Erosion Productivity Impact Calculator

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Download Information

Availability: Nonproprietary
Cost: N/A

Model Overview/Abstract

EPIC assesses the effects of soil erosion on productivity and predicts the effects of management decisions on soil, water, nutrient, and pesticide movements and their combined impact on soil loss, water quality, and crop yields for areas with homogeneous soils and management.

Model Features

- Simulates erosion effects on water quality
- Crop management tool that examines sediment, nutrient, and pesticide transport processes

Model Areas Supported

Watershed	Medium
Receiving Water	None
Ecological	None
Air	None
Groundwater	None

Model Capabilities

Conceptual Basis

EPIC is a field-scale model that was developed to assess the effects of soil erosion on agricultural productivity and water quality. It is used to examine farming practices and implementation activities.

EPIC has also been used widely for the study of global climate change. The USDA and Texas Agricultural Experimental Station (Texas A&M) jointly developed this version of the model called Environmental Policy Integrated Climate (EPIC).

Scientific Detail

EPIC is a continuous simulation model that has been used to examine long-term effects of various components of soil erosion on crop production (Williams et al., 1983). EPIC is a public domain model that has been used to examine the effects of soil erosion on crop production in over 60 different countries in Asia, South America, and Europe. The model is used to examine soil erosion, economic factors, hydrologic patterns, weather effects, nutrients, plant growth dynamics, and crop management. The major components in EPIC are weather simulation, hydrology, erosion-sedimentation, nutrient cycling, pesticide fate, plant growth, soil temperature, tillage, economics, and plant environment control.

The model requires input from GIS layers. These include soil series and weather data, although the model can generate the necessary weather parameters. The model also requires management information that can be input from a text file. Currently, there are many management files that exist for EPIC, and an effort is underway to catalog these files and provide them to users. The model provides output on crop yields, economics of fertilizer use, and crop values.

In the calculations for surface runoff, runoff volume is estimated by using a modification of the Soil Conservation Service (SCS) curve number technique. There are two options for estimating the peak runoff rate—the modified Rational formula and the SCS TR-55 method. The EPIC percolation component uses a storage routing technique to simulate flow through soil layers. When soil water content exceeds field capacity, the water flows through the soil layer. The reduction in soil water is simulated by a derived routing equation. Lateral subsurface flow is calculated simultaneously with percolation. The evapotranspiration is calculated in four ways, using the following equations:

- Hargreaves and Samani
- Penman
- Priestley-Taylor
- Penman-Monteith

The water table height is simulated without direct linkage to other soil water processes in the root zone to allow for offsite water effects. EPIC drives the water table up and down between input values of maximum and minimum depths from the surface.

The EPIC precipitation model developed by Nicks is a first-order Markov chain model. Temperature and radiation are simulated in EPIC by using a model developed by Richardson. The EPIC wind erosion model, WECS (Wind Erosion Continuous Simulation), is used to calculate wind characteristics, including erosion due to the wind. The relative humidity model simulates daily average relative humidity from the monthly average by using a triangular distribution.

To simulate rainfall/runoff erosion, EPIC used six equations—the USLE, the Onstad-Foster modification of the USLE, the MUSLE, two recently developed variations of MUSLE, and a MUSLE structure that accepts input coefficients. The six equations are identical except for their energy components. Contaminants, such as nitrogen and phosphorus, are used in the EPIC model. EPIC simulates the following processes involving contamination:

- Nitrate losses
- Contaminant transport due to soil water evaporation
- Organic nitrogen transport due to sediment

- Denitrification
- Mineralization
- Immobilization
- Nitrification
- Volatilization
- Soluble phosphorus loss in surface runoff
- Mineral phosphorus cycling

For climate change studies, the EPIC model appears to be the most complete model available for evapotranspiration cover design. The most noteworthy example is the MINK (Missouri-Iowa-Nebraska-Kansas) study (Rosenberg and Crosson, 1991). This study examined the effects of elevated CO_2 (EPIC had to be modified to incorporate sensitivity to CO_2) and temperature on crop yields, soil erosion, and economics in this four state region. The MINK study also provides general insights about the use of models for global change research.

Model Framework

- Field-scale, erosion based

Scale

Spatial Scale

- One-dimensional, agricultural field/farm scale

Temporal Scale

- Daily timestep, long-term simulations (1–4,000 years)

Assumptions

The model assumes that the dynamics of each physical, chemical, and biological component can be described by the principle of conservation of mass.

Model Strengths

- Has been used extensively to examine the effects of soil erosion and agricultural processes.
- Describes the phosphorus cycle and differentiates between all forms of phosphorus.
- Can be used to simulate the fate of agricultural pesticides.

Model Limitations

- Cannot represent watershed subsurface flow.
- Does not simulate sediment routing in detail.
- No mention of how the model deals with tile drains.

Application History

See available literature.

Model Evaluation

EPIC has been used extensively in the United State and abroad to predict soil erosion and effects, along with the potential costs associated with various management activities. See References for more information.

A soil loss model comparison was conducted by Bhuyan et al. 2002, which included evaluations of EPIC, ANSWERS, and WEPP. Although the results from all three models were within the range of observed values in the case study, WEPP soil loss predictions were the most accurate. However, WEPP cannot be used to examine water quality effects.

Model Inputs

- Daily timestep—long term simulations (1–4,000 years)
- Soil, weather, tillage, and crop parameter data supplied with model
- Soil profile can be divided into ten layers
- Homogeneous areas up to large fields
- Weather generation is optional

Users' Guide

Available online: http://www.wiz.uni-kassel.de/model_db/mdb/epic.html

Technical Hardware/Software Requirements

Computer hardware:

- PC

Operating system:

- PC-DOS, UNIX

Programming language:

- FORTRAN version 5125

Runtime estimates:

- Minutes (1 sec./simulation year)

Linkages Supported

Unknown

Related Systems

APEX – small watershed scale agricultural model

Sensitivity/Uncertainty/Calibration

See references. No specific tools available.

Model Interface Capabilities

- Spatial-EPIC is a recently developed GIS-based application for EPIC

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